

**Areva and EDF:**  
**Business prospects and risks in nuclear energy**

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**March 2009**

*Commissioned by Greenpeace International*

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## 1. Introduction

Areva and Electricité de France (EDF) are French-based companies at the heart of worldwide attempts to re-launch nuclear ordering – the so-called Nuclear Renaissance. Areva is an electricity industry equipment supplier offering transmission and distribution equipment as well as the full range of civil nuclear technologies. For its nuclear business, it operates as Areva NP, a joint venture with the German company Siemens in which Areva holds 66% and Siemens the balance, although in January 2009, Siemens announced it would be withdrawing from the joint venture (see below). EDF is an electric utility operating all the main generating technologies. The French state retains a majority holding in both companies although the priorities of their private shareholders, for EDF small shareholders and for Areva NP, Siemens, can no longer be ignored. In addition, the European Union law on unfair State Aids only allows governments to meet company losses or provide other assistance if such measures do not distort competition. For the markets Areva and EDF operate in, it would be hard to argue that any state aids did not distort competition.

While neither company is exclusively a nuclear company, both have made major strategic moves in the past few years that make their future prospects more heavily dependent on the success of the Nuclear Renaissance. This strategy is based almost entirely on the design currently offered by Areva, the EPR - European Pressurised Water Reactor in Europe but Evolutionary Pressurised water Reactor in the USA - which is the only reactor technology commercially offered by Areva and which EDF is committed to use in all the new orders it is involved in. There is particular pressure on Areva NP to get EPR right as its previous design, N4, contained a number of design errors that meant operation was unreliable for the first 3-4 years in service. Only four units were built, all in France and commissioned in the late 1990s before the design was superseded by EPR.<sup>1</sup>

In this report, we examine these potential markets, the roles EDF and Areva are hoping to play in them and the prospects and risks to the two companies these markets offer. Two orders for the EPR are under construction, in Finland at the Olkiluoto site and in France at Flamanville. Both sites have experienced serious problems with construction and the Olkiluoto site is severely over time and budget. We examine, in particular, the direct financial consequences of these problems as well as the risks in their other potential markets. We don't analyse in detail the risk to their reputation of problems at this site. In the long-term, this risk might be larger than the short-term direct financial risks, which can often be managed.

The key markets for Areva and EDF are:

- France
- USA
- UK
- China
- South Africa
- Finland.

The Indian market may also emerge as an important market and France has signed a nuclear cooperation agreement with India, which envisages the sale of two EPRs and their fuel.<sup>2</sup> However, Indian plans, which foresee 10 units supplied from Russia and 4 from the USA as well as the French orders seem highly optimistic.<sup>3</sup>

In section 2, we look at the nature of Areva and EDF's businesses, including the scale and scope of their operation. In particular, we look at how their nuclear businesses fit into their overall strategy and what steps the French government is able to take to support them. In Section 3, we look at the key markets for EDF and for the nuclear division of Areva, while in Section 4, we look at the business prospects for the EDF's and Areva's nuclear ambitions, in particular, assessing how realistic sales and expansion targets are. Finally, in Section 5, we identify the main risks to the businesses of EDF and Areva.

## **2. The nature of their businesses**

In this Section, we look at the scope and scale of EDF and Areva, in particular what factors influence their success or otherwise. Because of their close identification with the French government and its policy, we look at what scope theirs now is for the French government to provide assistance.

While both companies are involved in the electricity business, they are very different in terms of their cash-flow and risk profiles. An electric utility, especially one as large as EDF generates a massive cash-flow. A reactor power plant of an EPR size generates income of about €600m per year. In a competitive market, the key to the success of an electric utility is, in the short-term, to ensure that generation costs, excluding capital charges, are always lower than the wholesale electricity price. In the long-term, the electricity sale price must also cover the capital charges.

For nuclear plants, operating costs are generally seen as low compared to fossil fuel plants but it should be noted that British Energy collapsed in 2002 because its operating costs were higher than the price it was receiving for its power. Nuclear power is more problematic in this respect than fossil fuel stations because most of the nuclear costs are in the short-term fixed, whereas with a fossil fuel plant, the main cost is fuel, which is not incurred if the plant is not operated. By the standards of most products, demand for power is highly predictable, generally within 1% of forecast, thus in the past, there has been little demand risk. However, because of the huge cost of power stations, the cost of any over-forecasting of demand can be very high. In electricity markets that have been opened up to competition, demand risk becomes significant. There is little scope for product differentiation and brand loyalty for a standard product like electricity, so if an electric utility's power is not competitively priced, market share should, in theory, fall very sharply unless the utility is able to sell at a loss.

By contrast, an equipment vendor's business depends more on receiving sufficient orders for its high fixed costs to be spread thinly and its facilities kept loaded. It must also control the costs of production of the equipment. An equipment supplier's business is made up of the servicing requirement for supplied kit, which is reasonably predictable and smooth, and sales

of new equipment, which, particularly for large pieces of equipment could be extremely 'lumpy' and not always predictable. Areva's 'front-end' and 'back-end' services are reasonably smooth and predictable although the loss of a large contract could seriously impact on financial performance.

Where the two companies' interests can overlap is in the overall plant design and engineering areas. EDF has always carried out the design and architect engineering functions for the plants built in France. For the Olkiluoto order, Areva adopted an unaccustomed role as architect engineer and overall designer so that it had sufficient management control over the project to offer a turnkey contract. For orders that might be placed for UK, China, South Africa and USA, EDF would be much more deeply involved, for example, carrying out the overall plant design and managing the construction.

## 2.1 EDF

EDF was founded in 1946 as a fully state-owned company, formed mainly from the merger of former municipal companies, operating in electricity generation transmission and distribution. While there were a few small generation companies (for example, the nationalised coal company, Charbonnage de France) and some local authorities, such as Strasbourg, distributed electricity, it was an effective monopoly in all these activities. However, the European Union's Electricity Directive of 1996, revised in 2003, forced France to at least nominally open the French electricity sector to competition in generation and retail. Even more so than most state-owned electricity companies, the French government has treated EDF as an arm of government and used it to implement the most ambitious nuclear programme in the world. It now operates 58 nuclear reactors, all of the Pressurised Water Reactor (PWR) type.<sup>4</sup>

EDF is amongst the top five electric utilities in the world in terms of generating capacity owned, customers served, turnover etc. In November 2005, the French government sold 13.8 per cent of the shares of EDF in an Initial Public Offering. 15% of the shares sold were allocated to employees, while the rest was sold to the market (retail and institutional investors).<sup>5</sup> In 2007, the new Sarkozy French government sold a further 2.5 per cent of the shares, it claimed, to fund tertiary education. On December 31 2007, the French state owned 84.85 per cent of the shares.<sup>6</sup> Further share sales are expected. While the French government is required by law to retain at least 70 per cent of EDF's shares, there is no reason to assume a future French government will not repeal this law. Even if further shares are not sold, EDF probably no longer has the scope to knowingly trade in a way that it makes losses any more.

In the early 1990s, when the trend to privatise and liberalise electricity systems became important, EDF, along with a large number of US utilities, was one of the first and most prominent companies buying up foreign utilities. Its largest acquisitions were electricity distribution companies in Brazil (Light) and Argentina (Edenor). Of the other European electricity companies, only Endesa (Spain) and Tractebel (Belgium/France) made significant purchases outside Europe.<sup>7</sup>

By 2003, the US utilities had sold (or even abandoned) almost all their non-US assets, often losing large sums of money on them. EDF followed suit after making heavy losses in Brazil and Argentina, selling its stakes in all major assets outside Europe. This is reflected in the sharp fall in turnover in 'rest of the world' from 2005 to 2007 (see Table 2). Tables 1 to 3 show that EDF's business has grown slowly over the 3 years 2005-2007 with expansion in Europe more than compensating for the withdrawal from South America. From about 2000 onwards, its main priority seemed to be to expand into other markets in Europe. The rationale for these moves seemed to be to concentrate on relatively predictable markets (markets within the European Union have to comply with the EU Electricity Directive) and in regions which connected directly with the French market.

**Table 1 Basic statistics on EDF**

	<b>2005</b>	<b>2006</b>	<b>2007</b>
<b>Sales (€bn)</b>	51.0	58.9	59.6
<b>Of which in France (€bn)</b>	30.0	31.9	32.2
<b>EBITDA</b>	12.9	14.4	15.2
<b>Of which in France</b>	8.5	9.3	10.0
<b>Employees (th)</b>	162	156	159
<b>Of whom in France</b>	108	107	105
<b>Generating capacity (GW)</b>	131	128	127
<b>Of which in France (GW)</b>	99	98	98

Source: EDF Annual report and accounts 2006 and 2007<sup>8</sup>

**Table 2 EDF sales/EBITDA<sup>9</sup> (€m) by geographical area**

	<b>2005</b>	<b>2006</b>	<b>2007</b>
<b>France</b>	30015 / 8544	32081 / 8893	32608 / 9996
<b>UK</b>	6682 / 1306	8319 / 1268	8357 / 1285
<b>Germany</b>	5005 / 905	6065 / 996	6925 / 1031
<b>Italy</b>	2019 / 300	5615 / 928	4658 / 910
<b>Rest of Europe</b>	4446 / 1193	5434 / 1363	6827 / 1655
<b>Rest of World</b>	2880 / 658	2125 / 482	1270 / 333
<b>Total</b>	51047 / 12906	58932 / 13930	59637 / 15210

Source: EDF Annual report and accounts 2006 and 2007<sup>10</sup>

**Table 3 EDF sales (€m) by activity<sup>11</sup>**

	<b>Generation/supply<sup>12</sup></b>	<b>Distribution<sup>13</sup></b>	<b>Transmission<sup>14</sup></b>	<b>Other<sup>15</sup></b>	<b>Total</b>
<b>France</b>	20317	8551	3998	196	32232
<b>Rest of World</b>	21256	2126	16	4007	27405
<b>Total</b>	41573	10677	4014	4203	59637

Source: EDF Annual report and accounts 2006 and 2007<sup>16</sup>

EDF entered Germany from 2000 onwards taking a holding in EnBW, one of the four major German utilities. It entered UK in 1999 taking over London Electricity and subsequently other electricity industry companies and assets. It entered Italy by taking a stake in Edison in 2001. It tried to take stakes in major companies in Sweden and Spain, but these attempts were either repelled or abandoned. As in Italy, EDF's public ownership and the slowness of opening up of the French energy market led to resistance to it becoming a major presence in these markets. Since then it has built its stakes in EnBW and Edison and it has acquired other

UK assets (see below).<sup>17</sup> This allows EDF to trade between regional/national markets, including Germany, UK, Italy and the Benelux countries. For the purposes of their nuclear strategy, the Italian and German holdings would seem to be of no relevance in the short-term given the existence of nuclear phase-out policies in both countries although if the policies in both these countries on phase-out were to be reversed, this would change. The new investments in the USA and UK discussed below are clearly not reflected yet in the financial figures.

In terms of their business, generation and retail makes up about 70% of turnover and if EU rules on ‘unbundling’ (selling off the networks) are enforced rigorously, the other parts of the business, especially transmission, will decline further.<sup>18</sup>

### **2.1.1 EDF’s financial position**

By the start of 2008, all EDF’s significant assets were in Europe. However, in the second half of 2008, there appeared to be a change in EDF’s priorities towards a much greater concentration on linking its expansion into markets where it could build new nuclear. Its 2007 annual report states that the priority markets outside France are United States, China, UK and South Africa.<sup>19</sup> EDF made two major acquisitions in the second half of 2008, one in the UK and one in the USA. It agreed the take-over of the privatised British nuclear generator, British Energy in September 2008 and it agreed to take over 49 per cent of the nuclear assets of the US utility, Constellation.<sup>20</sup> These are major investments and their success is heavily dependent on prices in the wholesale electricity markets these nuclear plants sell into. If fossil fuel prices remain at the low level of early 2009 (oil less than US\$40/barrel), wholesale electricity prices could fall leaving nuclear generators in difficulties, as happened in 2002 in the UK with British Energy.<sup>21</sup>

In the past, EDF has always enjoyed access to cheap finance because its debts were fully backed by the French government so its credit rating was the same as that of the French government, which has always been Standard & Poor’s (S&P) highest rating, AAA. Now that EDF is partially privatised, this has changed and in December 2008 EDF was rated AA- for long-term debt and A-1+ for short-term debt, with a negative credit watch (i.e., the rating is likely to be lowered).<sup>22</sup>

EDF’s results announced in February 2009 showed that the strain of these acquisitions is beginning to show.<sup>23</sup> It announced it was expecting to sell assets to cut its debt, which had increased to €24.5bn at the end of 2008 from €16.3bn at the end of 2007.<sup>24</sup> If the agreement to sell 25% of British Energy to Centrica is concluded, this should yield about €3.4bn. However, Chief Executive Officer Pierre Gadonneix said:

‘We don’t exclude any component of our operations, in France or abroad,’ for possible sale, Gadonneix said. ‘We want to negotiate the best prices, so I won’t be more precise.’

Reconciling its plans to build nuclear plants in the UK, USA and China as well as France with keeping its debt and credit rating under control will be difficult.

## 2.2 Areva

The Areva Group was formed in 2001 from a merger of the French companies Framatome ANP, Cogema, FCI (Framatome Connectors International) and CEA Industrie, the nuclear energy division of the French Commissariat à l'Énergie Atomique (CEA; Atomic Energy Commission). Areva sold FCI in 2005 to focus on their energy business but in 2004, it took over the Transmission and Distribution division of Alstom.<sup>25</sup> The Areva Group now consists of three main subsidiaries: Areva NP, Areva NC and Areva T&D. Of these, all are fully owned by Areva except for Areva NP, the nuclear power division which is a joint venture with Siemens which holds 34 per cent of the shares, although it announced its intention to withdraw from the joint venture in January 2009. Areva NC is the fuel services division, carrying out what it classifies in its reports as the front end and back end activities - uranium mining, conversion and enrichment, spent fuel reprocessing and recycling.

The shareholding of Areva is complex but is totally dominated by the French state. The largest shareholders are the CEA (owned by the French government) with 79 per cent, the French state directly with 5 per cent, Caisse des Depots et Consignations (a publicly owned development bank) with 4 per cent, ERAP (a state-owned investment company) with 3 per cent and EDF 2 per cent.<sup>26</sup>

Areva has seen a number of major changes in the past 5 years. In 2004, it took over the Transmission & Distribution equipment business of the French company Alstom. From 2007 onwards, a number of further changes to its ownership and scope of business have been debated. One would be the part privatisation of Areva, a second would be a merger with Alstom, the French electrical engineering company, while a third would be for Bouygues, a French construction company to take a significant share in Areva. By end 2008, no decision on which option or combination of options would be taken.<sup>27</sup>

### 2.2.1 Areva's financial position

In January 2009, Siemens announced it would exercise its option to withdraw from the Areva NP joint venture no later than 2012, although press reports suggest that Siemens was hoping for a much quicker exit, perhaps within a year.<sup>28</sup> Standard & Poors said it expects the buyout of the Siemens' stake in Areva NP to take about six months. Under the shareholding arrangement underpinning Areva NP, Areva has the option to oblige Siemens to sell its share as of January 2012, with three years' advance notice. Siemens has the reciprocal option to oblige Areva to buy it out – so-called 'put' and 'call' options. The value of Siemens' 'put' is based on projections of future cash flows and was estimated in Areva's mid-2008 financial accounts at €2.1bn. Areva will clearly argue that the losses made by the division in recent years mean the €2.1bn figure is too high, while Siemens will argue that future orders mean that a figure close to the 2008 valuation is appropriate.

The withdrawal was not completely unexpected. Indeed, in 2007, the roles were reversed and the French government was reported to be looking for ways to remove Siemens from the joint venture.<sup>29</sup> Siemens seems to have become frustrated at its lack of strategic influence on Areva NP – 'lack of exercising entrepreneurial influence'.<sup>30</sup> The negotiations on the terms of the withdrawal will be complex and a particular bone of contention will be how quickly Siemens is able to compete again in the nuclear market. Under the terms of the joint venture, the



agreement setting up Areva NP prohibits Siemens from competing against Areva NP for eight years in areas of business where Siemens brought technology or facilities to the joint firm.<sup>31</sup> However, Siemens is reportedly in negotiations with the Russian nuclear vendor, Rosatom, to set up a joint venture and begin to compete against Areva NP in 5 years.

The need to buy out Siemens' stake will put considerable pressure on Areva's finances and is likely to force the French government to clarify its intentions for Areva – whether it will introduce part-privatisation, a merger with Alstom or allow Bouygues to take a stake. The strain it will place was apparent in quotes made to the press. The Economist quoted one French nuclear executive as saying: 'This is not the way you behave in business—normally you send signals.'<sup>32</sup> Standard & Poors said Areva's A-1 rating might be lowered to A-2 if Areva had to fully finance the buyout with new debt.<sup>33</sup>

Overall, like EDF, Areva may need to sell assets to fund its ambitious expansion plans.<sup>34</sup> Possible divisions to sell are its Transmission & Distribution division and its 26.43% share in a mining company, Eramet. In summer 2008, its level of debt was about €4.5bn and Areva was reluctant to take on more debt. However, it will need €10bn to finance its investment needs over the next four years as well as about €2bn to buy Siemens out of Areva NP.

### 2.2.2 Areva's businesses

Tables 4, 5 and 6 (see below) show that from 2005 onwards Areva has expanded its turnover, profit and number of employees. This expansion has come in all four of its main divisions except 'Back end' fuel services which have declined in turnover terms. By contrast, their 'Front end' and 'Back end' businesses are by far the most profitable parts of their business, while the profitability of the 'Reactors & services' division is consistently poor and, in 2007, it made a loss. The very poor figures on profitability for 'Reactors and services' are likely to reflect write-offs on the Olkiluoto contract. In its 2006 annual report, Areva added €452m to its 'provisions for losses to completion'. Areva stated that<sup>35</sup>: 'The provision recognized by the group in 2006 reflects the increase in costs and contingencies for this project [Olkiluoto].' In its 2007 annual report, it added further provisions of €361m to 'provisions for losses to completion', stating that<sup>36</sup>: '(t)his heading primarily includes losses to completion related to the OL3 [Olkiluoto] EPR construction contract.' Without these provisions, the profitability of this division would have been comparable to that of the other major divisions (see later for more detailed analysis). Standard & Poors gave Areva a credit rating for the first time in December 2008, when it gave it A-1, the second highest category, although the subsequent announcement by Siemens of its intention to withdraw from Areva NP has put this rating in doubt.<sup>37</sup>

Table 7 shows that about half of Areva's employees are based in France still but the proportion is declining with all other geographical locations growing in terms of employment.

**Table 4 Areva profile**

	2005	2006	2007
<b>Sales (€m)</b>	10,125	10,863	11,923
<b>EBITDA (€m)</b>	1,117	1,293	1,335
<b>Employees (th)</b>	59	61	66

Source: Areva Reference document 2006 and 2007.<sup>38</sup>

**Table 5 Turnover / EBITDA by division - €m**

	2005	2006	2007
<b>Front end</b>	2631 / 508	2919 / 630	3140 / 731
<b>Reactors &amp; services</b>	2348 / 173	2312 / 7	2717 / (125)
<b>Back end</b>	1921 / 483	1908 / 443	1738 / 440
<b>Transmission &amp; distribution</b>	3212 / 106	3724 / 258	4327 / 426
<b>Other<sup>39</sup></b>	14 / (53)	0 / (46)	1 / (137)
<b>Total</b>	10,125 / 1217	10863 / 1293	11923 / 1335

Source: Areva Reference document 2006 and 2007.<sup>40</sup>

Note: Figures in brackets denote losses.

**Table 6 Areva employees by activity**

	2005	2006	2007
<b>Front End</b>	11,047	11,995	12,577
<b>Reactors and Services</b>	14,323	14,936	16,500
<b>Back End</b>	10,864	10,697	10,638
<b>Transmission &amp; distribution</b>	22,094	22,988	25,248
<b>Other</b>	432	495	620
<b>Total</b>	58,760	61,111	65,583

Source: Areva Reference document 2006 and 2007.<sup>41</sup>

**Table 7 Areva employees by location**

	2005	2006	2007
<b>France</b>	31,194	31,240	32,224
<b>Europe (exc. France)</b>	12,085	13,456	14,556
<b>North &amp; South America</b>	7,912	7,497	8,717
<b>Africa &amp; Middle East</b>	1,745	2,519	2,638
<b>Asia-Pacific</b>	5,824	6,417	7,448
<b>Total</b>	58,760	61,111	65,583

Source: Areva Reference document 2006 and 2007.<sup>42</sup>

**Table 8 Areva turnover by region and activity (€m /2007/2006 change in %)**

	France	Europe (exc France)	N & S America	Asia Pacific	Africa & M East	Total
<b>Front End</b>	1108 / (15.4)	779 / 10.0	678 / 5.4	631 / 91.2	34 / (2.9)	3140 / 7.5
<b>Reactors &amp; Services</b>	946 / 6.8	814 / 18.5	638 / 22.2	238 / 30.1	81 / 138.2	2717 / 17.5
<b>Back End</b>	1000 / (11.1)	341 / (30.1)	86 / 10.3	310 / 44.2	1 /	1738 / (8.9)
<b>Transmission &amp; distribution</b>	348 / 10.1	1473 / 15.2	570 / (5.5)	1052 / 28.9	884 / 24.9	4327 / 16.2
<b>Total</b>	3313 / (6.1)	3407 / 7.7	1972 / 6.8	2231 / 44.4	1000 / 28.5	11923 / 9.8

Source: Areva Reference document 2006 and 2007.<sup>43</sup>

Note: Figures in brackets denote losses.

If we examine turnover by region and activity (see Table 8), we can see that in France, the 'Front end' and 'Back end' activities declined sharply in 2007, but France is still Areva's largest market for 'Reactors and services'. The 'Transmission & distribution' business is small in France. In the rest of Europe, the 'Back end' business is declining sharply as countries withdraw from spent fuel reprocessing. All other businesses are growing strongly. North & South America is still a relatively small part of the business but 'Reactors & services' is growing strongly there reflecting Areva's move into the US reactor servicing market. Asia Pacific is growing very strongly in all sectors, while Africa & Middle East is also growing strongly in 'Transmission & distribution' and 'Reactors & services' (albeit from a very low base for the latter).

### 2.2.3 Reactor services division

If we focus on the Reactor & Services, which contributes 23% of Areva's turnover, the division is further divided into 7 business units (see Table 9):

- Plants: design, construction and engineering of nuclear power plants;
- Equipment: design and fabrication of nuclear power plant components;
- Nuclear Services: maintenance, inspection and servicing of nuclear power plants;
- AREVA TA: design and fabrication of naval propulsion reactors and complex systems with a high level of safety;
- Nuclear Measurement: design and fabrication of nuclear measurement instrumentation;
- Consulting and Information Systems: consulting, systems integration and MIS outsourcing;
- Renewable Energies.

**Table 9 Reactor services revenue by activity (€m)**

	2007	2006
<b>Plants business unit</b>	1053	741
<b>Equipment business unit</b>	215	251
<b>Nuclear Services</b>	791	644
<b>AREVA TA</b>	308	314
<b>Nuclear Measurement</b>	159	175
<b>Consulting &amp; Information Systems</b>	157	156
<b>Renewable Energies</b>	35	32
<b>Total</b>	2718	2313

Source: Areva Reference document 2006 and 2007.<sup>44</sup>

The 'Plants' and 'Equipment' business units are the most volatile, depending most on new orders for plants. However, even in the 'Plants' division, in 2006, 'recurring business', that is work on operating reactors such as designing new instrumentation systems, accounted for nearly two thirds of the 'Plants' business turnover. Areva expects this proportion to fall as new orders are placed, but even this division has a continuing base-line of work not dependent on new orders. Further, the 'Equipment' division receives orders from the 'Plants' division and most of the equipment it supplies, like pressure vessels, are not replaceable, so recurring orders are a smaller proportion of the business, although replacement steam generators do represent a useful flow of orders (EDF is opening this market up to competition so Areva is not guaranteed this business). There is a capacity shortage for many of these major components, for example, the forgings for pressure vessels and Areva could supply material for other reactor vendors. Thus, it should be a profitable business if ordering of new reactors does take off, at least until the capacity shortage is overcome. Finally, the 'Nuclear

services' business unit's business is dominated by work on existing reactors and therefore represents a relatively stable market, albeit a highly competitive one, with a number of specialist service companies competing against the main vendors.

Overall, Areva's 'Reactor services' is not reliant on new orders. There is a large flow of work from existing reactors. In the past, vendors have been able to dominate the market on reactors they have sold for this 'recurring' work and this work has been very profitable, perhaps even justifying selling plant on 'loss-leader' terms. However, these markets are now highly competitive with vendors bidding to work on other vendors' plants and specialist companies. So the potential market has expanded, but its profitability and the riskiness of the market have increased.

Areva lists its existing and potential markets for new reactors as France, Finland and China (existing) and USA, UK, and South Africa for potential orders.<sup>45</sup> It also lists Bulgaria, but this work would involve completing a part-built Russian designed plant, so this market is not considered here. The South African utility, Eskom, abandoned plans to order 2 EPRs in December 2008<sup>46</sup>, so this market is also not considered further.

## **2.3 The French Government**

The French government is not able to support Areva and EDF to the same extent as in the past. The EU's Electricity Directive opens electricity markets to competition so EDF can no longer plan the entire French electricity generation sector. EU competition law also restricts the extent to which governments can subsidise their companies. In theory, if state assistance was sufficient to improve their competitive position, this would be regarded by the European Commission as 'unfair' state aid because it would distort markets.<sup>47</sup> The Commission's approval of the Olkiluoto guarantees is all the more inexplicable in this light.

The main area where the French government can still provide assistance, especially outside the EU, is through export credit guarantees from its agency Coface. Coface gave export credits to the Olkiluoto order. These were challenged by Greenpeace and EREF (see below) but the European Commission found on rather dubious grounds, that this did not constitute 'unfair state aid'.<sup>48</sup> Coface said in August 2008 that it was preparing to issue preliminary agreement to insure financing of two Areva EPRs at Taishan in China's Guangdong province (see below)<sup>49</sup>. At the same time, Coface announced an agreement to insure financing for two EPRs that could be built in South Africa. The extent of the guarantees Coface would supply was not disclosed but after the collapse of the South African tender, Areva claimed it would be able to cover 85 percent of the cost from OECD export credit agencies.<sup>50</sup> The report did not specify which apart from Coface would participate. Without these guarantees, finance would be much more difficult to arrange, particularly for developing country markets. Areva does not have the financial scope to offer finance, while EDF would be able to offer some finance if it took an equity stake in the new plants, as it is doing in UK, USA and China.

### 3. EDF and Areva's key markets

In this section we examine in detail the markets EDF and Areva have targeted for their nuclear businesses. We examine what investments they have made and what the prospects and risks are that their strategy entails.

#### 3.1 France

France remains the key market for both EDF and Areva. France's 58 PWRs (63GW), all owned by EDF<sup>51</sup> were brought into service mainly in the period 1977-1992, when they were expected to have an operating life of 40 years. These provide Areva with a flow of reasonably assured servicing work, that no other vendor can match. The strategic importance of the EPR to EDF was therefore to have a proven technology that was available to replace the existing plants. Simply to replace these plants as they were retired would have required the completion of about 2-3 EPRs per year from 2017 onwards.<sup>52</sup> The Olkiluoto order of 2004 was therefore a useful first step in gaining experience with the EPR, while the Flamanville order placed by EDF in 2007 gave EDF some first-hand experience with the technology so that when regular orders were needed, EDF would have the right skills available.

In practice, a number of factors mean this steady flow of orders for EPRs by EDF in France might not materialise:

- There is now an expectation that PWRs will be licensable for 60 years so the main replacement need would not materialise until after 2030;
- EDF no longer has a monopoly in France and the merger of GDF (the publicly controlled gas company) with Suez (whose main business is the dominant Belgian electric utility, Electrabel) means that some form of competition to EDF will emerge. This will mean that EDF cannot centrally plan the French electricity system: it will be subject to market forces;
- There is already over-capacity in nuclear power in France, which means the existing plants cannot always easily be fully utilised.

These factors mean that the demand for new generating capacity to replace old PWRs is unlikely to arise and it cannot be assumed that any new capacity needed will be chosen and built by EDF.

##### 3.1.1 EDF in France

###### Life extension

While EDF has, for more than a decade, wanted to establish the EPR as a commercial technology, in the past 3-4 years, a number of factors mean that the priority to order plants to start to replace the existing nuclear plants may be less.

In the USA, the regulatory case to allow PWRs to be licensed to operate for up to 60 years instead of the original assumption of 40 years is now well-established. Whether PWRs can actually operate for 60 years is not proven given that the oldest operating PWR worldwide is still only 40 years old. Unlike the USA, the French regulator does not license plants for a specific period but licensing is renewed every 10 years. French operators must instead demonstrate to safety authorities every 10 years that each unit is safe to continue to operate for the next decade. The first two units will undergo their 30-year inspections in 2009 (the process is running a little late).

The original EDF assumption was that the plants would operate for 40 years or less, so, assuming a 5-6 year construction period, construction on the replacement plants would have had to start around 2010. However, in December 2008, EDF expressed its intention to operate its 900MW units (34 units completed between 1977 and 1990) for up to 60 years. The Chief Financial Officer, Daniel Camus, said all EDF's "focus, and all our maintenance work, is dedicated to operating the reactors past the 40-year mark.", and "we will never promise to get to 60 years, but we will commit to do everything to get from 40 to 50, and from 50 to 60 years."<sup>53</sup>

There would be huge logistical benefits of not having to find and gain approval for new reactor sites and not having to manage a large number of construction projects. Not having to build new plants would also avoid exacerbating the severe international shortage of nuclear skills. EDF also faces an uncertain role in the French market, unless the spirit of the European Union's Electricity Directive, which requires that national electricity generation monopolies are replaced by a single competitive European electricity market, can be ignored. EDF will have to dramatically reduce its generation market share in France. In such a situation, building new generation capacity would be extremely risky and would be seen as politically provocative. One alternative would be to build plants in collaboration with other utilities, as it is doing with ENEL at the Flamanville plant (see below). Suez GDF, which has limited experience in building nuclear power plants and would like to expand its French electricity business, might also be a suitable partner. The company already has stakes in two EDF sites, Tricastin and Chooz (1100MW) and competed with ENEL to take a stake in Flamanville.<sup>54</sup>

In July 2008, President Sarkozy announced that a second EPR would be built in France at a site yet to be identified.<sup>55</sup> Subsequently, Sarkozy specified the site would be Penly and EDF would be the majority owner with GDF taking a minority share.<sup>56</sup> GDF would build the third unit. Construction was forecast to start in 2011.<sup>57</sup>

There would also be huge financial pay-offs to EDF if the lives of its existing plants could be extended to 60 years. EDF assumes that a maintenance and upgrade expenditure of €400m per reactor and using this figure, EDF calculated that the net value of extending all 34 900MW reactors to 60 years would be about €40bn.<sup>58</sup>

There would be particular financial benefits for decommissioning funds. The Planning Act on Sustainable Management of Radioactive Materials and Waste (Birraux Act) of 2006 required that EDF must clearly identify and segregate assets that will pay for waste disposal, spent fuel processing and decommissioning.<sup>59</sup> Previously EDF had made accounting provisions for

these activities but the provisions were not separated or identified and, in effect, EDF could use these funds to fund its international expansion and its national investment needs. At the end of 2006, the dedicated assets were worth €6bn. EDF then expected it would have identified assets backing its entire projected nuclear liabilities of about €16bn by the end of 2010 (see Table 10).

**Table 10 Provisions for back-end activities - €m**

	2005	2006	2007
Provisions for decommissioning& last core	13136	13824	13654
Provisions to cover the back-end of the fuel cycle	14752	15381	17455

Source: EDF Consolidated Financial Statements, 2006 and 2007.<sup>60</sup>

The discounted liability for decommissioning (using a 3% real interest rate) was estimated at about €13bn or about €250m per reactor.<sup>61</sup> This seems a very low figure and if the figure turns out to be significantly more, the additional operating life would allow a further 20 years to collect funds and it would also allow the provisions to grow from the interest the funds accrue. EDF is allowed to assume that provisions grow in real terms (net of inflation) at 3% per year<sup>62</sup>, which over 20 years, would add 80% to the funds.

While life extension would make financial sense to EDF, it would leave the programme of French EPR orders in tatters. If the plan to extend lives to 60 years was successful, there would be no need for substantial ordering for France before about 2030. By this time, the EPR design would most likely have needed, as a minimum, major modifications to maintain licensability. It may be that one of the rationales for EDF's aggressive move into international markets is the need to generate a sufficient flow of orders for the EPR to keep it a viable option for the home market.

### **Flamanville 3**

The Olkiluoto order for an EPR, decided in 2003 and placed in 2004, was a major advantage to EDF. It allowed the EPR design to be demonstrated in practice without EDF having to build unwanted capacity. Apart from delaying the time when investment from EDF was needed it also allowed someone else to have to deal with the inevitable 'first-of-a-kind' problems. However, when the EPR received final design approval from the French regulator, DGSNR, in 2004, EDF decided to test the technology with one order for the Flamanville site<sup>63</sup> where two 1300MW plans were already in operation. The reactor was formally ordered in 2006 and work on the site began in December 2007.

EDF's estimated construction cost and construction time were somewhat higher than those adopted for Olkiluoto. In March 2006, it emerged that EDF expected the second EPR order, for its Flamanville site, to cost €3.3bn, 10% more than the contracted Olkiluoto price) and that the lead-time would be 54 months instead of the 48 month period forecast for Olkiluoto.<sup>64</sup> However, unlike the Olkiluoto contract, this cost does not include the cost of the first fuel load (conventionally included in the cost of a nuclear plant), while the Olkiluoto price includes interest during construction.<sup>65</sup> The very low interest rate applied at Olkiluoto means that in this case, interest during construction will be low.<sup>66</sup> So the difference between the Olkiluoto price and the Flamanville price is larger than the headline figures suggest.

ENEL, the largest Italian electric utility has taken a 12.5% stake in Flamanville 3 and will contribute proportionately to the finance. The 2007 EDF Annual Report states:

“On November 30, 2007, EDF and Enel signed a strategic partnership agreement, under which Enel bears a 12.5% share in all construction, operation, decommissioning and back-end nuclear cycle management expenses for the Flamanville 3 EPR-type nuclear plant, in return for access to 12.5% of the electricity generated by the EPR over its lifetime. The plant’s nuclear operator is EDF, which bears full responsibility for its operations. The partnership agreement also gives Enel the option of progressively acquiring the electricity generated by EDF’s nuclear plants, up to a total capacity of 1,200 MW.”<sup>67</sup>

And:

“Enel also has an option, until 2023, to take a 12.5% stake under similar terms in the five potential EPR projects likely to be implemented by EDF in France up to that date.”<sup>68</sup>

One important difference between Flamanville and Olkiluoto was that Olkiluoto was a full turn-key contract between Areva NP and Olkiluoto’s owner, TVO. This means that the plant construction was fully managed by Areva NP and the price was fixed at the level in the contract. This was a route EDF has never followed as it has always carried out the ‘architect engineering’. For Flamanville 3, Areva is supplying the nuclear island, Alstom the turbine generator, Bouygues, the civil works and EDF itself the architect engineering.

In May 2008, the French safety regulatory authorities temporarily halted construction because of quality issues in pouring the concrete base mat.<sup>69</sup> Delays had led the vendor, Areva NP to forecast that the plant would not be completed until 2013, a year late. However, in November 2008, EDF claimed that the delays could be made up without major changes to working patterns and that it had learnt from these early errors.<sup>70</sup>

EDF’s civil works contractor Bouygues encountered major delays in 2008 in attempting to excavate the discharge channel at Flamanville-3 with explosives, due to denser-than-anticipated granite. This was overcome by using a tunnel boring machine at an extra cost of €40m.<sup>71</sup> EDF did acknowledge that the expected construction costs for Flamanville had increased from €3.3 billion to €4 billion.<sup>72</sup> Inflation and technical and regulatory changes were blamed by EDF for the bulk of the 20% cost overrun on the overnight cost of Flamanville. Higher prices for commodities and labor since the previous cost projection accounted for a smaller percentage of the re-evaluation. Nucleonics Week reported that:

“Inflation accounted for an 8% rise above the 2005 estimate, or about €250m in 2008 €, resulting in a base figure of €3.55bn. About €150m was added to that for price re-evaluations, notably for raw materials (copper, nickel, and titanium), steel and labor. Part of that rise was due to revision of indexed prices under early contracts, and another part to higher-than-anticipated prices for the 20% of Flamanville-3 contracts EDF has concluded since 2005. Those revisions brought the cost to €3.7bn. Mathias [EDF CEO] said the cost of solving technical problems, meeting new safety regulations, and increasing contingency reserves added another €300m, or about another 8%, bringing the new total to €4bn.”<sup>73</sup>

Flamanville costs were reported to be inflated because it, rather than Olkiluoto, bore first-of-a-kind (FOAK) costs including development and design engineering costs.<sup>74</sup> EDF has not specified the extent of FOAK costs at Flamanville 3, but in the past it has estimated that the cost of a FOAK can be double that of a series unit assuming a series of at least 10 units.<sup>75</sup>



However, EDF has stated that a second EPR in France would still be more expensive. There would be no series effect until at least three or four units had been built.<sup>76</sup> EDF claimed there would be savings on construction costs thanks to the learning from Flamanville-3, but those savings would be offset by a tighter market for materials and equipment than when EDF placed the Flamanville contracts in 2004 and 2005.<sup>77</sup>

#### **Impact of delays and cost overruns on EDF**

EDF is in a unique position worldwide in having more nuclear capacity in France than it can use. As a result, it has had to reduce the output from some of its nuclear plants at times of low electricity demand and it has even had to bring back into service a 700MW oil-fired unit, closed for 12 years because it needed peaking capacity that the nuclear units cannot supply. It is therefore far from clear how the output of Flamanville could be used. At periods of low demand, it is likely to simply substitute for other nuclear plants, while for the rest of the year it would substitute for fossil fuel plants. Whether the savings from substituting for fossil fuel plants would counterbalance the extra nuclear running costs for Flamanville 3 is hard to determine without access to details of EDF's cost structure. Also, whether the available extra output could be sold to export markets profitably is difficult to determine. The impact of a delay in completing the plant might be quite limited because of the over-capacity that EDF has.

EDF's tariffs for its residential consumers are still regulated and how much it could recover of any additional costs would ultimately be the decision of the French government – the Regulatory body, CRE, provides advice to the government but the government is not obliged to accept this advice. Similarly, if the costs of Flamanville were to overrun, it would be a decision for the government/regulator whether EDF would be forced to take this extra cost out of its profits. If the extra cost was 50% or about €2bn, it was forced to take this from profits and it wrote the extra cost off over several years, the impact on its overall profits would be quite small given that EDF's profits are more than €15bn per year.

#### **3.1.2 Areva in France**

For Areva, the French market is crucial for its EPR business. If there is no flow of orders from France, it will be very difficult to generate sufficient export orders to keep the business viable. So the decision on life-extension is of central importance. If the life of the existing PWRs is extended to 60 years, there will be no substantial ordering for the French market until 2030, by which time the EPR is highly unlikely to be a commercial design.

For the Flamanville plant, the impact of any cost or time overruns would be largely indirect provided it can supply the equipment it is contracted for at the contract price. In practice, nuclear cost escalation occurs either because of design changes or because of on-site problems. For the Flamanville plant, Areva is not responsible for any on-site problems, it is simply an equipment supplier. The indirect impact of significant problems at Flamanville, in terms of the damage to its reputation of major problems at both of the European EPR sites would be much greater.

## 3.2 Finland

### 3.2.1 Areva in Finland

The Finnish electricity industry had been trying to get Parliamentary approval for a fifth nuclear unit since 1992 and finally succeeded in 2002. The Olkiluoto order, placed in 2004, was a huge boost for the nuclear industry in general and the vendor, Areva NP, in particular. The benefits for EDF were indirect however and EDF has had no part to play in the construction of the plant. When complete it will provide a demonstration and reference to other prospective buyers for the EPR. Equally significantly, the Olkiluoto order seemed to show that nuclear power orders were possible in competitive electricity markets. Finland is part of what is generally seen as the most competitive electricity market in the world, the Nordic market covering Norway, Sweden, Finland and Denmark. Finland also has a very high reputation for the operation of the 4 units that it owns.

#### **The contract terms**

The details of how the plant would be financed have not been published, but the European Renewable Energies Federation (EREF) and Greenpeace separately made complaints to the European Commission in December 2004 that they contravened European State aid regulations.<sup>78</sup> The Commission did not begin to investigate the complaints until October 2006 and, in September 2007, the European Commission Competition authorities dropped the case.<sup>79</sup> According to EREF, the Bayerische Landesbank (BLB, owned by the state of Bavaria) led the syndicate (with Handelsbanken, Nordea, BNP Paribas and J P Morgan) that provided the majority of the finance. It provided a loan of €1.95 billion, about 60 percent of the total cost at a remarkably low interest rate of 2.6 percent.<sup>80</sup>

Two export credit institutions are also involved: France's Coface, with a €610 million export credit guarantee covering Areva supplies, and the Swedish Export Agency SEK for €110 million.<sup>81</sup> Again, this is a surprising feature as export credit guarantees are usually offered only for exports to developing countries with unstable economies, not a category that Finland falls into.

The buyer Teollisuuden Voima Oy (TVO) is an organization unique to Finland. Pohjolan Voima Oy (PVO), the largest shareholder holds 60 percent of TVO's shares. PVO is a not-for-profit company owned by Finnish electric-intensive industry that generates about 15 percent of Finland's electricity. Its shareholders are entitled to purchase electricity at cost in proportion to the size of their equity stakes. In return, they are obliged to pay fixed costs according to the percentage of their stakes and variable costs in proportion to the volume of electricity they consume. The other main shareholder in TVO is the largest Finnish electricity company, Fortum, with 25 percent of the shares. The majority of shares in Fortum are owned by the Finnish Government.<sup>82</sup> This arrangement is therefore effectively a contract for the output of Olkiluoto 3 over the full life of the plant at prices set to fully cover what ever costs are incurred.

Overall then, the economic risks of building this plant were borne by consumers, through the cost-plus terms of the contract, French (and Swedish) taxpayers through the credit guarantees and the vendor, Areva NP (majority owned by the French public), through the turnkey contract.

### Experience at Olkiluoto

From the start in 2005, the construction period at Olkiluoto went seriously wrong, so that after three years of construction, in November 2008, the plant was three years behind schedule and the vendor, Areva, was suffering severe losses.<sup>83</sup> This was not the result of a particular problem but the result of a range of failures including: welding, delays in detailed designs, problems with concrete and with the quality of some equipment. More generally, it seemed that none of the parties involved including the vendor, the customer, or the safety regulator had a clear enough understanding of the requirements building a nuclear plant placed on them.

In December 2006, the French Ministry of Industry (the French government owns more than 90 percent of Areva) said that the losses to Areva had reached €700 million on a contract fixed at €3 billion.<sup>84</sup> The turnkey contract was widely seen as placing all the risk of cost-escalation on Areva NP. However, even before substantial work had been carried out, Areva acknowledged the price was not as fixed as it was portrayed as being. Bertrand Durrande, an executive vice president at Areva NP said that “even a turnkey contract doesn't guarantee that a customer won't pay a penny more.”<sup>85</sup> He explained that the contract with TVO covered a certain scope for which ‘there's a fixed price’ in the original contract. But, Durrande said, “when you reach the construction phase, there are always a certain number of discussions because one or both parties realize that the original contract doesn't cover everything, or that some things must be changed.”<sup>86</sup>

A year later, the strains inherent in a turnkey contract for such a complicated order were becoming apparent. Philippe Knoche, an Areva NP representative stated, “Areva-Siemens cannot accept 100 percent compensation responsibility, because the project is one of vast co-operation. The building site is joint so we absolutely deny 100 percent compensation principle.”<sup>87</sup> TVO did not accept this interpretation and the TVO project manager, Martin Landtman, when asked about Knoche's statement said, “I don't believe that Areva says this. The site is in the contractor's hands at the moment. Of course, in the end, TVO is responsible of what happens at the site. But the realization of the project is Areva's responsibility.”<sup>88</sup> It may well be that this dispute will have to be settled in court.

On the finance side, the leader of the syndicate of banks, BLB, had to be rescued by the German government. In November 2008, it received the first installment of guarantees from the German government for €15 billion.<sup>89</sup> If this is sufficient to stabilize the bank's finances, the loan to TVO should not be affected.

Compensation for delays has already reached the limit of €300 million that would be payable for a delay of 18 months. TVO will not receive compensation for further delays beyond those already incurred by September 2006. The possibility that the cost of buying the power Olkiluoto was expected to produce during the years 2009-12 from the Nordic market might be so high as to cause TVO to default can no longer be ignored. TVO will have to buy power from the Nordic electricity wholesale market for at least three years. Generating capacity is getting tight in the Nordic market and because the system is dependent on hydro-electricity, it is vulnerable to dry winters, which in the past few years have led to wholesale prices

increasing up to five-fold. For the energy intensive consumers that make up PVO's customer base, high and volatile electricity prices are intolerable.

In December 2008, TVO announced that the Areva-Siemens consortium that was supplying the plant had filed a request for arbitration concerning the delay and related costs. Its press release stated:

"The request relates to a claim presented previously by the consortium to TVO, which TVO has studied and found to be without merit. Understandably, TVO will carefully study the documentation now presented and will respond to it. As stated by TVO in its interim review of January - June 2008, TVO has earlier claimed for compensation from the plant supplier for losses and costs incurred due to the delay to the project."<sup>90</sup>

The outcome of the arbitration case is not predictable and the most recent estimates of the cost overrun were more than a year old in December 2008 and ranged from €0.5-1.5bn.<sup>91</sup> In March 2008, Nucleonics Week reported:

"Areva said it did not record further provisions against potential losses on OL3 in second-half 2007, and Lauvergeon continued to decline to identify the amounts recorded in 2006 and first-half 2007. Analysts have estimated those provisions at €700m, but some estimates put the potential loss at completion of the project at €1.5bn."<sup>92</sup>

Subsequently, in September 2008 Areva NP reported an operating loss of €258m in the first half of 2008, after the company made new, unspecified provisions for Olkiluoto. Despite this, Standard & Poors gave Areva a high credit rating in December 2008. It said it did not expect lasting negative impacts from the Olkiluoto nor did they expect Siemens to exercise its 'put option' to sell its 34% stake in Areva NP.<sup>93</sup> This latter prediction was quickly proved incorrect (see above) and Areva's credit rating might fall from A-1 to A-2. Siemens did announce charges of €344m for the Olkiluoto deal in its 2008 annual report<sup>94</sup>. This was in addition to earlier provisions, which it had declined to quantify.

The Finnish press reported in December 2008 that Areva had announced that it was not interested in future nuclear power projects in Finland.<sup>95</sup>

The question that is so far unanswered from the Olkiluoto experience is whether this is an isolated failure or whether it is a demonstration that the old problems of unpredictable construction costs and times have not been solved.

#### **Further orders**

Despite the problems with Olkiluoto 3, three utilities have announced they would like to build a further nuclear unit in Finland. First, TVO has announced it would like to build a fourth unit at the Olkiluoto site. It has already completed an Environmental Impact Assessment (EIA) which claimed a new unit of 1000-1800MW could be online in 2018, which implies ordering in about 2012<sup>96</sup>. However, no decision has been taken on the vendor and the EIA identified nine possible designs (including EPR).

Second, Fortum has announced it would like to build a new unit at the Loviisa site where two Russian designed plants are in operation. Fortum submitted an EIA for this site in April 2008<sup>97</sup>. As with Olkiluoto 4, no reactor type or vendor has been identified yet, but construction was forecast to start in 2012 with completion in 2018.

The third possible developer, Fennovoima, a consortium of about 60 Finnish companies, including electric utilities, is examining four sites and submitted an EIA in January 2008.<sup>98</sup> In January 2009, Fennovoima applied to the Ministry of Employment and the Economy for a decision in principle on the project. Fennovoima expects to bring a new plant (one or two units) of 1500-2500MW on line in 2020<sup>99</sup>. It has identified Westinghouse/Toshiba and Areva as the two most likely vendors.

The Minister for Economic Affairs, Mauri Pekkarinen, has said that Finland would only need one new reactor by 2020. The Finnish government expects to make a decision in early 2010.<sup>100</sup>

How far these applications are seen as complimentary and how far they are seen as competing is difficult to say, but it is difficult to see how Finland could accommodate the output of three new units of, say, 1700MW, increasing Finland's installed capacity by about 50% unless much of the output was exported (this would need substantial new transmission capacity).

#### **Risks to Areva of Olkiluoto**

The direct consequences of cost overruns, unless a large proportion can be passed on to the customer will make a significant impression on Areva's profits. Areva has already written off about €800m so this amount has no more impact on Areva. The profitability of the 'Reactors and services' division has been well below that of the other divisions in 2006 and 2007 but these other divisions are large enough that Areva remained a profitable company in those years. If it can phase any further losses over the next 3 years, the impact should be relatively small. The indirect consequences are likely to be much higher. Olkiluoto was supposed to be the showcase for EPR technology and for it to have gone so badly wrong is severe blow to its reputation. Even more damaging is the spectacle of Areva suing its customer and this may harm its chances if a further reactor order for Finland is approved.

### **3.3 UK**

#### **3.3.1 EDF in UK**

EDF entered UK in 1999 with the purchase of London Electricity (see above), a distribution and retail electricity company with a small amount of generating capacity. Subsequently it bought the retail businesses of two more of the previous 12 regional retail companies of England and Wales (South West and South East) and two more of the distribution ('wires') businesses (Eastern and South East). EDF also bought coal (4000MW) and gas fired (800MW) capacity so that by 2007, it owned 4.9GW of generation.<sup>101</sup> This makes EDF the largest distributor of electricity in the UK (with 7.9m consumers) but only the 5<sup>th</sup> largest retailer (with 5.5m consumers), although the market shares of the 6 big retailers are reasonably comparable.<sup>102</sup> EDF is a relatively small generator producing only 25.4TWh in

2007, all allocated to its residential and SME customers.<sup>103</sup> It buys the rest of its requirements, for its industrial consumers, from the market and from the 2000MW interconnector to France. This policy of covering its sales to residential and SME customers from its own plants, buying the rest of its needs from the market is a policy largely followed by the other 5 large generator/retail companies in Britain. The industrial consumer ‘market’ is supplied to a significant extent by the nuclear capacity owned by British Energy (10.7GW).

**Table 11 EDF in UK**

	<b>2007 (% change from 2006)</b>
<b>Sales (£m)</b>	5744 (1.2)
<b>Of which electricity (£m)</b>	3895 (-2.6)
<b>Profit before tax (£m)</b>	342 (-15.6)
<b>Electricity sales (GWh)</b>	52435 (-1.9)
<b>Number of retail customers (th)</b>	5539 (+0.8)
<b>Generating capacity (GW)</b>	4.9 (0)

Source: EDF Energy (2007)<sup>104</sup>

**Table 12 Generating capacity in Britain**

	<b>Generating capacity (GW)</b>
<b>RWE</b>	10.7
<b>British Energy</b>	10.7
<b>E.ON</b>	9.8
<b>Scottish &amp; Southern</b>	9.3
<b>Scottish Power</b>	6.4
<b>EDF</b>	4.8
<b>Centrica</b>	3.5
<b>Others</b>	18.0
<b>Total</b>	73.1

Source: DECC (2008)<sup>105</sup>

## **The take-over of British Energy**

British Energy was created in 1996 as a privatised electricity generation company to own all except the first generation nuclear plants in Britain (excluding the ‘Magnox’ plants). This gave them about 10GW of generating capacity comprising 1 PWR and 7 Advanced Gas-Cooled Reactor stations, each of about 1200MW and comprising 2 reactors. The economics of these plants were so poor that the sale price was only £1.7bn, so effectively the plants were given away. The company prospered while the wholesale electricity price was high but by 2002, when the wholesale price was low, British Energy’s income from electricity sales was less than its costs and the company collapsed. A rescue plan was brought in by the UK government and the company re-launched in 2005 (the plants had continued to operate in the interim). This cost taxpayers in the region £10bn.<sup>106</sup>

Since then, the business has prospered again, but only because of very high energy prices. The fundamentals of the business have generally deteriorated significantly. In 2002, when the company collapsed, the operating cost of the nuclear plants was about £16/MWh. British Energy subsequently acknowledged expenditure on maintenance was less than was necessary for the long-term reliability of the plants. Since 2002, when operating costs were at their

historic low, costs have risen sharply. In 2007/08, operating costs were £30/MWh compared to £27.1/MWh in 2006/07, an increase of 11%, while the realised price was down by 8% from £44.2/MWh to £40.7/MWh.<sup>107</sup> Output in TWh was the same (54.1TWh) as in the previous year but 20% down on 2003/04.<sup>108</sup> Half year results can be misleading but for the first half of 2008/09, while realised price was somewhat up, operating costs were £41.3/MWh, 60% up on the previous comparable period and output was 30% down on the previous period.<sup>109</sup>

While British Energy is hopeful that some of the problems that caused this reduction in output can be solved, it is far from clear that, as in the past, new problems to replace them will not arise. Of the 7 AGRs, which originally had a licensed life of 30 years, two are already more than 30 years old, while three more are about 25 years old and the other two are 20 years old. Only the PWR, completed in 1995 can confidently be expected to operate for more than 10 years into the future. If electricity prices continue to fall from their high point in summer 2008, British Energy's financial position will look precarious.

The 'price' for the rescue of British Energy by taxpayers was that the British government was effectively given a 67% stake in the company. In 2007, the British government sold about half these shares to the market and in 2008, it expressed an interest in disposing of its remaining shares but as part of a deal that led to the takeover of the whole company. A number of companies expressed an interest but only EDF placed a firm bid. The initial bid was rejected but an increased bid of £12.5bn was accepted in September 2008. Exchange rates were unstable in the second half of 2008 but at the rates prevailing in September 2008, this valued the company at about €15bn.<sup>110</sup>

### **The deal**

The deal was a relatively complicated one because of its size and strategic importance. The size of the deal meant that EDF could not pay for British Energy in cash as it had done with most previous acquisitions. The company was bought by Lake Acquisitions, a wholly owned subsidiary of EDF. EDF said it would finance the deal through a syndicated loan, a revolving credit with an average interest rate of 7%, which would provide €13.9 bn. EDF said it would provide the rest in cash. An agreement has been made with Centrica that it would take 25% of Lake Acquisitions at a cost of £3.1bn<sup>111</sup>. By January 2009, the deal had not yet been completed. Centrica raised £2.2bn from its shareholders through a rights issue and this is expected to fund most of the acquisition if the deal is completed.<sup>112</sup>

From a regulatory point of view, the deal had to be approved by the competition authorities, for EDF, the European Commission's competition authorities. Approval was given in December 2008 but on the following conditions: British Energy must sell a 2000MW coal-fired plant (Eggborough) and EDF must sell an 800MW gas-fired plant (Sutton Bridge).<sup>113</sup> EDF must also agree to sell minimum amounts of electricity in the UK wholesale market, dispose of land at either Dungeness or Heysham that could be used to build a new nuclear power station, and end one of its three connection agreements with National Grid. The plant disposals and the sale of the stake to Centrica would leave EDF with about 10.8GW of generating plant, almost the same as its three largest rivals E.ON, RWE and Scottish & Southern.<sup>114</sup> Centrica would end up with about the same amount of capacity as Scottish Power. It is not clear what the implications of selling a certain amount of power to the market

would be. Whether the land disposal and the surrendering of a grid connection agreement will make other companies more likely to build nuclear plants in UK is far from clear. The acquisition by Centrica of 25% of British Energy would also have to clear UK anti-trust authorities.

### **Rationale**

There were three factors identified by EDF as being behind its decision to take over British Energy. First, as the tables show, EDF has much less generating capacity than its competitors, and the addition of the British Energy capacity would, as argued above, put EDF on a par, in terms of generating capacity with its main rivals. Second, the acquisition gave it ownership of all parts of all the main sites where new nuclear power plants could be built in the UK, in particular, sites where two new EPRs could readily be accommodated. Third, the highly problematic nature of the British Energy plants means British Energy needs a disproportionately large staff of skilled nuclear specialists to keep these plants on-line, which EDF can accommodate. This represents a useful skill base especially in Anglophone markets, such as South Africa and USA.

While these three points have some logic, the deal is far from convincing. The price looks very high, especially given that there were no competing bidders and given the deteriorating economics of the ageing stock of reactors EDF was taking on. Little would have been lost by waiting a year during which lower output and falling electricity price would have been likely to significantly reduce the price. EDF argues that it needs to increase its generation to be on par with its main rivals, however there is a significant amount of coal and gas-fired plant not owned by its rivals it could probably have purchased.

The argument on sites seems no stronger. Of the 7 sites owned by British Energy, two (Hunterston and Torness) are in Scotland, which has taken a decision not to allow construction of new nuclear plants.<sup>115</sup> Hartlepool is not suitable for a new nuclear plant. This leaves Heysham, Sizewell, Dungeness and Hinkley Point. However, all these sites, except Heysham also house Magnox stations owned by the government's Nuclear Decommissioning Authority (NDA), which would be anxious to gain income from selling the sites. The other site mentioned as suitable for twin units, Wylfa, is owned mainly by the NDA. It seems inconceivable that the UK government, which since 2006 has always stressed its priority to have more than one company building nuclear power plants in Britain would allow any company, including EDF, to be prevented from building plants because it did not have access to the sites or a grid connection.

### **3.3.2 Areva in UK**

Areva NP has not been a major supplier to the UK, so it would depend on the companies that might build plants in the UK choosing them as supplier. EDF would almost certainly choose Areva NP. While E.ON had signed a memorandum of understanding with Areva to use the EPR design, it was reported in January 2009 that it had backed away from that commitment. RWE is understood to favour the Westinghouse AP-1000, so if E.ON and RWE build plants in the UK in collaboration, the AP-1000 may be the more likely reactor choice.<sup>116</sup> Iberdrola, the Spanish owner of Scottish Power, announced in January 2009 that it might build nuclear plants in UK, but it supported the EPR, the ESBWR (now withdrawn) and the AP-1000 in the



UK's generic design assessment,<sup>117</sup> so even if it were to enter the UK market, it is far from clear that it would order the EPR.

In 2007, Areva NP submitted its EPR design as one of four designs to be considered by the UK Nuclear Installations Inspectorate (NII) for certification in the UK. Of the three other designs, the Canadian ACR-1000 and the GE ESBWR were both withdrawn leaving only the EPR and the Westinghouse/Toshiba AP-1000. NII has experienced considerable difficulties recruiting inspectors and is still some 40 inspectors below its required number. Approval for these two designs is not expected before about 2010/11. In December 2008, Areva announced agreements with UK firms Balfour Beatty and Rolls Royce and with Vinci (its UK subsidiary is Taylor Woodrow) to become suppliers for EPRs.<sup>118</sup> If nuclear build does go ahead in the UK, it seems likely that EDF will be one of the main players and it would be very surprising if EDF was to choose a design other than the Areva EPR.

### 3.4 USA

#### 3.4.1 EDF in the USA

EDF's first significant entry into the USA was in 2005 through the creation of the Unistar 50-50 joint venture with the US utility, Constellation. Unistar would build new nuclear plants using the EPR design, which, in December 2008, had a target date for certification by the NRC of February 2012. Constellation owns about 3.9GW of existing nuclear power plants at three sites (Calvert Cliffs, Nine Mile Point and Ginna)<sup>119</sup>.

In September 2008, EDF tried to take over Constellation but were outbid by MidAmerican Energy Holdings, a private company controlled by Warren Buffet. It was reported that the rival bid for Constellation could derail their nuclear ambitions in the USA if MidAmerican did not support new nuclear build. However, in December 2008, EDF announced an agreement with Constellation to take a 49.99% holding in Constellation's nuclear subsidiary, Constellation Energy Nuclear Group. The deal was done through the EDF subsidiary, EDF Development Inc, and will cost US\$4.5bn.<sup>120</sup> Mid American Holdings amicably withdrew its offer. The Unistar joint venture will remain separate from this deal.

Whether the purchase of the stake in Constellation's nuclear assets would make any sense without the new build plants is far from clear. However, it is clear that EDF regards it as part of its bid to build new plant and expand the scope of its operations into plant design and construction. Nucleonics Week reported: "EDF Chairman/CEO Pierre Gadonneix defended the decision to buy what some in France are calling 'old' US nuclear plants as a ticket to what will be 'the world's largest nuclear market tomorrow'."<sup>121</sup>

The purchase has received a mixed reception with a number of commentators believing that EDF had overpaid for assets for which there were no separate accounts.<sup>122</sup> The price of US\$2400/kW seems high for reactors that range from 21-40 years old.<sup>123</sup>

Unistar plans to build EPRs at up to three sites: Calvert Cliffs, Nine Mile Point and a new site, Elmore (see below). By December 2008, the US NRC had received and accepted for detailed review (docketed) applications for Combined Construction and Operating License (COL) for three units of the four units. Each unit is in a different regulatory jurisdiction and has unique features so they need to be considered separately. The NRC's review is expected to take 36-42 months, and state regulatory review also is required. For loan guarantees, utilities were required to make a Part 1 application for funds by September 2008. Part 1 application has a US\$200,000 non-refundable fee. The DOE received Part I applications for a total of US\$122 billion in guarantees to support 21 new nuclear reactors. The department reviewed the Part I applications and gave a priority ranking to each project to help guide utilities as to whether to make the Part 2 application, which had to be in by December 2008. Part 2 has a US\$600,000 non-refundable fee.<sup>124</sup>

**Table 13 Status of Unistar applications**

	<b>NRC Process</b>	<b>DOE Loan guarantees</b>
<b>Nine Mile Point 3, 4</b>	COLA <sup>125</sup> submitted	Part 1 submitted, part 2 deferred
<b>Calvert Cliffs 3</b>	COLA submitted	Parts 1 & 2 submitted
<b>Elmore</b>	COLA expected Q3 2009	-

Source: NRC, 2008<sup>126</sup>

The Calvert Cliffs project is 100% Unistar and is the most advanced of the Unistar projects. It is forecast to cost US\$7.2bn.<sup>127</sup> Unistar ordered forgings and other long lead-time reactor components for Calvert Cliffs in 2006 and 2007. A partial COLA, mainly the environmental report, was submitted in July 2007 and was docketed by the NRC in January 2008. The remainder of the COLA was submitted in March 2008 and was docketed on June 4, 2008. The COL could be issued in March 2012. However, Unistar has said it hopes to break ground as early as the regulatory process allows, which could be in 2009 and the most optimistic completion date is 2015, although this looks very unlikely to be achieved. Part 1 of the application for Federal loan guarantees was submitted within the deadlines (September 2008) while Unistar expected to submit Part 2 within the deadline of December 2008.<sup>128</sup> Further, the Nine Mile Point project is also 100% Unistar. The Combined Construction and Licensing Application (COLA) for this site was submitted in September 2008 and docketed in December 2008. Unistar submitted a Part 1 application for Federal loan guarantees within the September 29 2008 DOE deadline, but did not submit Part 2 within the December 2 deadline.<sup>129</sup> A company spokesperson said an application would only be submitted if Congress provided more funding. Finally, the Elmore site is still at an early stage of approval and a COLA is not expected to be submitted before end 2009.

Overall, of the sites owned by Unistar, only the Calvert Cliffs site seems to have made significant progress and incurred major costs for EDF. Constellation has said it will not make a final decision on building new plants until “we’re satisfied that our expectations have been met concerning safety, cost and regulatory support.”<sup>130</sup> The US DOE ‘nuclear power deployment scorecard’<sup>131</sup>, updated on January 7, 2009, stated that despite at least 6 years of effort, ‘no utility has committed to constructing a new advanced reactor’ under the Nuclear 2010 programme that President Bush launched in 2002.

It is difficult to quantify EDF's commitment to the US market. The stake in Unistar cost them US\$4.5bn. It has also provided Constellation with US\$600m in liquidity and Constellation has an option to sell EDF a stake in some of its non-nuclear assets for US\$2bn, so this deal may cost EDF more than US\$7bn<sup>132</sup>. The extent of EDF's financial commitment to Unistar is even more difficult to evaluate.

The investment in the USA appears quite speculative. Credit guarantees seem the key for the initial orders to be placed. Unless the new Obama administration is prepared to increase its offer of credit guarantees from the current figure of US\$18.5bn to in excess of about US\$100bn, any US programme may well be confined to a handful of units.<sup>133</sup> Whether orders will be possible without credit guarantees is far from clear. If nuclear ordering did not resume, EDF's investment in the USA would have little logic and, as it had to do with investments in Brazil and Argentina, they would be sold again, potentially at a significant loss.

### 3.4.2 Areva in the USA

Areva has also made a significant commitment to the US market. Apart from the reactors that Unistar is hoping to build, three other US utilities have chosen the EPR for their plans to build nuclear power plants, all using Unistar experience and expertise. The Bell Bend site is a PPL (Pennsylvania Power and Light) project. A COLA was submitted in October 2008 and docketed two months later. PPL submitted a Part 2 application for loan guarantees in December 2008. AmerenUE has submitted and had docketed a COLA and has applied for loan guarantees for a unit at its Callaway site. Amarillo Power has announced its intention to build two EPRs but it is not expecting to submit a COLA before the 4<sup>th</sup> quarter of 2009.<sup>134</sup>

Areva is seeking US Federal loan guarantees for its planned uranium enrichment plant in Idaho. It is competing with two other companies to build enrichment capacity in the USA.<sup>135</sup> The US DOE has set aside US\$2bn in loan guarantees to pay for enrichment capacity, which may be in short supply within a few years. The Areva plant is expected to cost about US\$2bn. Regulatory review by the NRC is expected to take about 2-3 years so construction could start as early as 2011, with operations commencing in 2014. Areva plans to employ 250 full-time workers at the operational site and 1,000 during construction.<sup>136</sup>

Areva has also announced a joint venture with the US company, Northrop, to build a reactor component manufacturing facility in Newport News.<sup>137</sup> It would produce reactor vessels, steam generators, pressurisers and other large items of equipment. Work is expected to start on the facility in the first half of 2009, with completion scheduled for 2011. Areva Newport News will then receive forgings from their points of origin (Japan Steel Works (JSW) and Creusot Forge in France) and will fabricate the reactor components. The factory is expected to cost US\$363m and will create about 500 skilled jobs. JSW will supply Areva with large forged parts for nuclear power plants until 2016 and beyond under an agreement announced by the two companies on November 4 2008 (Areva has also taken 1.3% of JSW's stock).<sup>138</sup>

The NRC process represents a significant risk to Areva. The EPR design has received certification by the Finnish and French regulators and is undergoing review by the British

regulator. However, in January 2009, the US design review process was still 3 years from completion (longer than the Finnish regulator took), so the NRC is clearly not assuming any analysis carried out by other regulators. There is therefore a significant risk that NRC could ask for significant design changes, which could raise costs and at worst, could be embarrassing for the Finnish and French authorities if they are seen to have approved design features that were not acceptable to US regulators.

Overall, Areva has made a major commitment to the US market. Whether the enrichment and component manufacturing capacity it is hoping to build would make sense if the US market failed to materialise is far from clear.

## 3.5 China

### 3.5.1 Areva in China

China has, for more than 3 decades, been seen as a major new market for nuclear vendors. In practice, this promise has never been realised for two main reasons: nuclear ordering in China has consistently been at a much lower level than forecast by the Chinese authorities; and China is reluctant to import plants unless technology transfer is part of the deal. It seems to prefer to import one or two units with strong technology transfer terms included and then build further units without foreign assistance.

Nevertheless, Framatome won orders for two 900MW PWRs (Daya Bay) after a lengthy period of negotiations. Construction started in 1987 and was completed in 1994<sup>139</sup>. China has subsequently completed (2 units) or has under construction (9 units) 11 units of essentially the same design, without any significant input from Areva. It also bought two units of the Candu design (construction start 1998), which the Canadian vendor, AECL hoped would lead to further orders, but none has materialised. Similarly, it has completed two units imported from Russia (construction start 1999), but again there is no immediate prospect of further orders.

Further, China's State Nuclear Power Technology Co ordered 4 AP-1000 plants (at the Sanmen and Haiyang sites) in March 2007 from Toshiba/Westinghouse after a tender process lasting about 5 years and in competition with Areva's EPR design. The deal included the 'blueprints' for the design. Construction work is expected to start in 2009. It was reported that Areva's reluctance to transfer technology hampered its bid. Xinhua Financial News reported:

"Stephen Kidd, director of strategy and research at the World Nuclear Association, said that the French company lost out to Westinghouse, now owned by Japan's Toshiba, because it was unwilling to transfer key technologies and thereby serve Chinese efforts to localize advanced PWR technology. "(Areva) wanted to keep the blueprints for their reactor design to themselves," Kidd said."<sup>140</sup>

However, in November 2007, Areva announced a deal to supply 2 EPRs (at the Taishan site) to China for completion in 2013/14. Xinhua Financial News reported:

“Areva will deliver uranium and other essential products and services for the two reactors until 2026, according to the French company. It has also agreed to transfer key EPR technologies to the China Guangdong Nuclear Power Corporation (CGNPC).”<sup>141</sup>

The contract to Areva was reported to be for €8bn covering the nuclear island and the fuel.<sup>142</sup> Other costs, such as on-site costs are substantial but have not been reported so the overall forecast cost of the plants is not known.

How far this order represents a change in policy by Areva on technology transfer has not been clarified. However, it seems clear that there are highly unlikely to be any follow-up orders for either Westinghouse/Toshiba or Areva unless there is a major change in Chinese policy. Indeed, Areva might find that Chinese vendors will be competing against them, with similar technologies and very competitive prices in international nuclear markets.

### 3.5.2 EDF in China

EDF has been involved in nuclear projects in China for more than 25 years. For the Daya Bay project, EDF provided project assistance and technical supervision for construction and also won some training and service contracts. EDF was also a consultant and contractor for the two-unit Ling Ao station between 2002 and 2004. However, its involvement in the EPR deal is much more significant. In August 2008, EDF took a 30% stake in a joint venture with Guangdong Nuclear Power Holding Company to form a new company, Taishan Nuclear Power Company (TNPC), building two EPRs at Taishan, in China's Guangdong province. EDF will retain its 30% stake in TNPC for 50 years — the maximum permitted for a joint venture in China.<sup>143</sup> The order has been valued at €8bn and if EDF takes 30% of this, its nuclear investment in China will be at least about €2.5bn.<sup>144</sup>

### 3.6 Other markets

Areva has been linked to a number of other markets, including South Africa, India and the UAE. However, the call for bids the South African utility, Eskom, made in 2008, in which Areva NP was competing with Westinghouse/Toshiba was abandoned in December 2008 and it is far from clear if and when the competition might be re-opened. This was despite the fact that Areva claimed it could have backed 85% of the cost of the plant by export credit guarantees. This illustrates the important point that export credit guarantees are of more value to the plant vendor, because they ensure they will be paid, than to the utility. Export credit guarantees do not prevent the utility going bankrupt, nor do they protect the utility's credit rating. Engineering News reported that the issue was the credit rating of Eskom:<sup>145</sup>

‘In fact, ratings agency Standard & Poor's said on Thursday that South Africa's National Treasury needed to extend “unconditional, timely guarantees” across all Eskom's debt stock if it hoped to sustain the utility's current BBB+ investment-grade credit rating. The National Treasury was still to announce the details of the package.’

It has been reported that a memorandum of understanding (MOU), including the intention to build two EPRs, would be signed in February 2009 between Areva and the state-owned Nuclear Power Corporation of India Limited.<sup>146</sup> Even if this MOU is signed, it is far from being a firm order and many MOUs come to nothing, for example, if finance cannot be arranged.

There has also been speculation about orders for the UAE and some UAE interests have spoken about a reactor being on-line by 2017. However, given that the UAE had not set up a functional regulatory agency and that there would be political issues that might get in the way of orders being placed, this seems hopelessly optimistic.

#### **4. The market for EPRs**

Four EPRs have been sold already (two to China and one each to Finland and France). As noted above, the Finnish and the French order have gone badly but, in the case of Olkiluoto, a significant proportion of the losses have already been written off, and Areva is not so exposed to losses at Flamanville because it is not a turnkey project.

Where might additional sales come from? Plans involving EDF and Areva have been announced to build a further 11 units in France, UK and the USA. None of these projects have yet been firmly ordered. While there is a strong likelihood that a few EPR orders will be placed in France, if life extension for the existing plants is feasible, the market could be no more than a handful of units. In France, President Sarkozy has announced that France will build a second and third EPR to follow-up EDF's Flamanville order, the second to be built by EDF at its Penly site and the third to be built by GDF Suez at a site yet to be determined.<sup>147</sup>

In the USA, US utilities have announced plans to build six units of the EPR design.<sup>148</sup> However, there is no certainty that any orders will be placed unless the new US government offers loan guarantees. The amount of loan guarantees offered will determine how many of the approximately 30 announced projects will actually be built. If significantly more is not offered than was planned at the start of 2009, no more than about 4 units will be built. It is unclear whether any of these will be EPRs, but only 1 US EPR project is reasonably advanced and it is behind several other projects in the queue.

Finally, EDF has stated its intention to order up to 5 EPRs for the UK market.<sup>149</sup> In the UK, EDF is clearly ahead of its rival utilities in planning nuclear plants, but the sticking point might be the UK government's stated determination not to offer subsidies to new nuclear units. If, in 3-4 years time, when design approval has been given and site consent given, EDF finds it cannot proceed without subsidies and these are not forthcoming, it may be that no orders will be placed.

Beyond these relatively well developed proposals, there are a number of possible markets, but all are still speculative. There are utility plans to build another nuclear unit in Finland. However, there still has to be political approval won for a new unit and the utility chosen to build it (of the three competing) has to choose EPR over competing designs. This seems far from certain given the poor experience with Olkiluoto 3.

UAE has made optimistic projections about nuclear capacity, but even if these were to result in orders, it is not clear these would go to Areva. Earlier press reports that Areva had been

chosen as vendor have proved premature and the UAE has signed a number of co-operation agreements with countries other than France and with other vendors.

How quickly the situation in South Africa with regard to Eskom's credit rating might improve is hard to predict, but if the South African government and Eskom believed it was just a matter of a year or two, they would surely have put the tender on hold, instead of abandoning it. China is a large potential market but all past experience suggests that now China has imported 2 EPRs, any further units of that design will be supplied from China.

Other markets are even further off, e.g., Turkey, Brazil, Viet Nam, Canada and Switzerland while some, e.g., Germany, Italy, Spain and Belgium would require major political reverses that would be politically highly contentious.

Thus, in the next five years, it seems unlikely Areva will win more than a handful of units and in the next decade, perhaps 10-15 would be the maximum. Beyond that, a number of additional markets could open up and the range of uncertainty is much higher, but past experience suggests that the proportion of orders that materialise in comparison with those projected is very low. In addition, by then, unless there is a large number of orders for EPR that allow its updating, it may well have been rendered obsolescent by newer, more advanced designs.

For Areva, the consequences of this uncertainty are not necessarily very serious. If few orders are placed, it still has its main business, which is servicing, providing fuel services and spares for the existing fleet of reactors. It is unlikely to spend large amounts of money on new equipment production facilities until the flow of orders is sufficiently large to clearly warrant this investment.

EDF claims the cost-over-run at Flamanville because of the problems suffered in the first year of construction are in the order of 20% of the total cost but it is not clear how reliable this figure is. EDF's dominant position in the French electricity market may mean it can still pass any losses on to consumers and given that annual sales in France are in excess of €32bn, a cost over-run of less than €1bn, spread over several years would have little impact on electricity prices even if it was fully passed on to consumers unless the regulator can persuade the government to take some very tough decisions on electricity prices. This seems unlikely.

## **5. Conclusion**

This report examines the financial situations of EDF and Areva and, in particular, what the impact of problems at the Olkiluoto and Flamanville nuclear construction sites will be on these companies and their shareholders. It looks at how dependent these companies are on the achievement of their objective to obtain orders for at least 35 more EPRs in the next decade and it examines what part these companies will have in financing these orders.



## 5.1 Public ownership

The ownership of both companies is dominated by the French government and the government has consistently used its ownership of these companies as an arm of government policy. For example in the 1970s and 1980s, EDF and Areva's predecessor, Framatome, was given whatever resources and backing needed to carry through the government's nuclear ambitions. The French government continues to use these companies as a policy instrument and is therefore unlikely to want to lose control of these companies. While there is a likelihood that the French government will sell some more EDF shares and that private capital will come into Areva, for example through Bouygues, ownership is likely to continue to be dominated by the French government. For the foreseeable future, the shareholders of the two companies will essentially be the French government, especially after the withdrawal of Siemens from Areva NP. The withdrawal of Siemens from Areva NP, apparently because it was unable to influence Areva NP's policies sufficiently will also remove a potential obstacle to the French government influencing Areva's policies to meet its own priorities. However, the withdrawal of Siemens from Areva NP does present financial problems because of the need to find the capital to buy Siemens out. It remains to be seen whether it will lose significant technical expertise and how quickly Siemens can emerge as a major competitor in nuclear markets.

Government ownership is a strength and a weakness to both companies. It gives both companies huge financial strength and strategic backing in world markets, for example through loan guarantees for export orders. However, the French government's policy objectives might not always align with the corporate interests of the two companies. For example, the French government could impose restructuring on Areva, such as privatisation, merger with Alstom or a partnership with Bouygues, which are not in Areva's own interests.

## 5.2 The French market for Areva and EDF

Any plausible cost overruns at Flamanville, which will represent less than 2% of EDF's generating capacity in France, can probably easily be absorbed, while the output is not needed to meet French demand so construction time overrun will also have little impact. However, it seems implausible that the European Commission will allow EDF to continue to have a *de facto* monopoly in the French electricity market and at least one major competitor, probably GDF Suez, is likely to be given or allowed to take a significant proportion of the market. What this will mean for the existing nuclear plants is far from clear. Transferring a proportion of them to a competitor would be highly contentious and would be fiercely resisted, but even if EDF retains these, it seems likely that EDF's ability to use its French customer base to underwrite foreign investments will be reduced. The proposal to extend the lives of the existing plants to 60 years probably makes economic sense to EDF. However, if the plants were kept in operation for an additional 20 years, the market for EPRs in France would be very small and it would make it hard for EDF to retain its capabilities as a nuclear plant designer and engineer.

For Areva, it will be difficult for any competitors to make any impression on the French market share but even the threat of limited competition could erode Areva's profit margins.



The company's reprocessing business is likely to shrink unless the trend to plan to dispose of spent fuel directly is reversed. EDF will be reluctant to reprocess its spent fuel if, as seems likely, direct disposal is cheaper. EDF's proposal to extend the lives of its existing plants to 60 years means that the huge replacement market for reactors in France that Areva was expecting would dominate its EPR sales is effectively indefinitely postponed and its future reactor sales can only be a small proportion of those previously expected.

## 5.4 Foreign markets

EDF has adopted a new policy in the last year of investing heavily in electric utilities in markets where it hopes to build and operate EPRs and it has announced it expects to invest up to €50bn in new nuclear power plants worldwide by 2020.<sup>150</sup> In the UK and the USA, EDF has bought existing nuclear power plants as well as planning to build new ones. It has bought British Energy for about €15bn, 49.9% of Constellation's nuclear assets for about €6bn (USA). Its British Energy and Constellation investments have been criticised for being over-priced. Losses with existing plants can mount up very fast, as was illustrated in the UK in 2002 when British Energy collapsed alarmingly quickly because the cost of its power fell marginally below the market price. If the nuclear markets in USA and UK do not materialise, EDF could be left with some very expensive assets of limited value. For China, EDF has taken a minority stake in a company building new nuclear plants while its role in South Africa, if any, is not yet clear. If the projected sales of EPRs other than those in USA and the UK do not materialise, the impact on EDF will probably not be major. It would have acquired the resources it would need to fulfil these plans and if the plans do not materialise, it will simply not acquire these resources.

Areva is also investing heavily in foreign markets, especially the USA, where it is expecting to build major new facilities. For future reactor sales, Areva NP is heavily committed to just one reactor design, the EPR, with its other options a long way from commercial application. Its projections of reactor sales do not seem realistic and if the manufacturing facilities it is building are left under-utilised, this could be costly to them. If the EPR continues to encounter technical problems or if the US (or UK) safety regulatory processes throw up significant issues, Areva NP will have serious problems remaining a credible reactor vendor, especially after its errors with its previous design, the N4. Unless it can salvage the Olkiluoto project, which is three years late and at least 50% over-budget, very quickly, the damage to its reputation will be severe. Prospective customers will hardly be impressed by a vendor locked in a bitter struggle with one of its customers, appearing to try to renege on a turn-key contract.

## 5.5 Finance, debt and credit ratings

Both EDF and Areva have long had a stream of secure business with limited competition that dominates their financial position. In the case of EDF, it is the French electricity market, where it has an effective monopoly over most sectors of the market. For Areva, there are its reactor servicing and fuel supply businesses especially in France where it has had a market for the 58 operating reactors with little realistic competition. These large, relatively secure

markets are on such a scale that the losses even from major failures such as the Olkiluoto project and perhaps the Flamanville project can be absorbed over 3 or 4 years with relatively little impact on their overall profits. They have also allowed the companies to take on relatively risky investments, such as EDF's investments in South America secure in the knowledge that these would be underwritten by their core businesses. However, both companies appear to be moving in to a period where these secure businesses will become more risky. This comes at a time when their strategic plans call for major investments, which will tend to significantly increase their debt levels, perhaps putting their high credit rating at risk. Both companies have said they want to sell existing businesses to keep their indebtedness under control, but whether they can find businesses to sell that will not damage their corporate prospects and will raise enough money to achieve this remains to be seen. A weakening of their credit rating will have consequences that will be felt throughout their businesses.

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- <sup>12</sup> Generation/Supply: this segment covers all expertise and assets required to generate energy and sell it to industry, local authorities, small businesses and residential consumers
- <sup>13</sup> Distribution: this consists of managing the low and medium-voltage public distribution network
- <sup>14</sup> Transmission: this involves operating, maintaining and expanding the high-voltage and very-high-voltage electricity transmission network
- <sup>15</sup> Other: this category consists of energy services (district heating, thermal energy services, etc.) for industry and local authorities, as well as new segments mainly aimed at boosting electricity generation through cogeneration and renewable energy sources (e.g. wind turbines, solar panels, etc.).
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- <sup>121</sup> Nucleonics Week, 2008. 'In France, EDF/CEG deal draws fire, but seen as key to EPR series cost' December 25, 2008.
- <sup>122</sup> ibid
- <sup>123</sup> ibid
- <sup>124</sup> US Department of Energy, 2008 'Loan guarantee solicitation announcement: Federal loan guarantees for nuclear power facilities, USDOE, Washington, p 22. Accessed on January 27, 2009 at <http://www.lgprogram.energy.gov/NuclPowerSol7-11-08Amend1.pdf>
- <sup>125</sup> COLA: Combined Construction and Licensing Application
- <sup>126</sup> <http://www.nrc.gov/reactors/new-reactors/col.html>. Accessed on January 27, 2009.
- <sup>127</sup> Electric Utility Week, 2008 'Regulators back expansion of Calvert Cliffs, but environmentalists ask for preconditions' December 1, 2008, p 28.
- <sup>128</sup> Part 1 application has a US\$200,000 non-refundable fee, while Part 2 has a US\$600,000 non-refundable fee.
- <sup>129</sup> Nucleonics Week, 2008. 'Loan guarantee application deadline draws multiple requests' December 25, 2008, p 1.
- <sup>130</sup> McClatchy-Tribune Business News 'Areva looks to federal loan guarantees for new reactors' October 20, 2008.
- <sup>131</sup> <http://www.ne.doe.gov/np2010/neScorecard/neScorecard.html>
- <sup>132</sup> Nucleonics Week, 2008. 'In France, EDF/CEG deal draws fire, but seen as key to EPR series cost' December 25, 2008.
- <sup>133</sup> If we assume three units of each design being evaluated by the NRC are built at a cost of about US\$9bn each and loan guarantees cover the maximum amount, 80% of total cost, allowed under US Department of Energy rules, guarantees of US\$108bn would be needed.
- <sup>134</sup> Nuclear News, 2008. 'Renaissance Watch' December 2008, p 20.
- <sup>135</sup> The US Enrichment Corporation has also applied for loan guarantees and GE-Hitachi is also expected to apply for loan guarantees in 2009 for its enrichment plant. See Inside NRC, 2009 'Areva delivers application to NRC for Eagle Rock enrichment plant' January 5, 2009, p 3

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- <sup>137</sup> Nucleonics Week, 2008. 'Heavy component manufacturing for new reactors to return to US' October 30, 2009, p 5
- <sup>138</sup> Nuclear News, 2008 'Areva Moved to secure supplies of large forged parts' December 2008, p 43.
- <sup>139</sup> <http://www.iaea.or.at/programmes/a2/> Accessed January 27, 2009.
- <sup>140</sup> Xinhua Financial News 'Correction: France's Areva confirms 8 Bln EUR nuclear deal with China - UPDATE 3' November 26, 2007
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- <sup>149</sup> Nucleonics Week, 2008 'EDF sees EPR series easing construction in four countries' April 17, 2008, p 1.
- <sup>150</sup> World Nuclear News, 2008 'EdF plans for future nuclear growth' December 4, 2008. Accessed on January 27, 2009 at [http://www.world-nuclear-news.org/C-EdF\\_plans\\_for\\_future\\_nuclear\\_growth-0412084.html](http://www.world-nuclear-news.org/C-EdF_plans_for_future_nuclear_growth-0412084.html)